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Verification Trial of Soil Test based Fertilizer Prescription Model for Wheat in Anand District of Gujarat

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A B S T R A C T

A field experiment was conducted to study "Verification trial of soil test based fertilizer prescription model for wheat in Anand district of Gujarat" during 2017-18. The texture of the soil is loamy sand. The verification trial of wheat conducted at three locations of Anand district. The fertilizer recommendations based on initial soil test values for different yield target of wheat (40, 50 and 60 q ha^{-1}) under NPK alone and NPK with 10 t FYM ha^{-1} at three locations were calculated. The targeted yield treatments (40, 50 and 60 q ha^{-1}) with and without FYM significantly increased grain yield, straw yield, nutrient uptake and maintained fertility status and also gave higher value of produce, per cent achievement, net gain over control and B:C ratio at all locations over RDF. The STCR treatments (40, 50 and 60 q ha^{-1} targeted yield) with 10 t FYM ha^{-1} was superior over STCR treatments (40, 50 and 60 q ha^{-1} targeted yield) without FYM in terms of grain yield, nutrients uptake and fertility status of the soil.

Introduction

Wheat is one of the most important cereal crops grown in India. Wheat cultivation in India traditionally been dominated by the northern region of India. Total estimated wheat production of India is 101.20 million tonnes during 2018-19 which is higher by 1.33 million tonnes as compared to wheat production of 99.87 million tonnes achieved during 2017-18 (Anonymous, 2019). In Gujarat, wheat is grown in about 6 to 7 lakh hectares, of which irrigated wheat contribute about 75 to 80 per cent and remaining 20 to 25 per cent area under rainfed cultivation (ICAR). Soil test based fertilizer use is must for sustainable agriculture (Rao and Srivastava, 2000). The fertilizer application by

the farmers in the field without information of soil fertility status and nutrient requirement of different crops usually leads to adverse effect on soil as well as crops by way of nutrient deficiency or toxicity due to over use or inadequate use of fertilizers. In this regard, targeted yield approach has been found to be beneficial which recommend balanced nutrition considering soil available nutrient status and the crop requirement. Theory of formulating optimum fertilizer recommendations for targeted yields was first given by Troug(1960) which was further modified by Ramamoorthy *et al.,* (1967) as "Inductive cum targeted yield model". Addition of Integrated Plant Nutrition System (IPNS) to this concept ensures balanced fertilization by application of inorganic and organic sources of nutrients. They showed linear relationship between grain yield and nutrient uptake.

Materials and Methods

The experimental soil is representative of the Anand district and locally known as *Goradu* soil. The texture of the soil is loamy sand and suitable for variety of crops of tropical and sub-tropical regions. In order to test the validity of derived yield targeting equations for recommending fertilizer alone or in combination with FYM for targeted production of wheat, field experiment was conducted at three locations: i) Agronomy farm, ii) RRS farm, iii) Farmer's field at Hadgud. Initial soil samples (0-15 cm) were collected from the experimental site of these locations and analyzed for organic carbon (Walkley and Black, 1934), available N (Subbiah and Asija, 1956), available P_2O_5 (Olsen *et al.,* 1954) and available K_2O (Jackson, 1973). The initial soil test value of three locations are given in Table 1. The design of field experiment was Randomized Block Design (RBD) with twelve treatments and three replications. The soil test based fertilizer prescription equations for wheat under NPK alone and NPK with 10 t ha^{-1} FYM are given below:

NPK alone: FN = 4.81 T - 0.41 SN, FP = 2.30 T - 1.18 SP_2O_5 and FK = 2.08 T - 0.19 SK_2O

NPK with 10 t FYM ha^{-1}:FN = 4.81 T - 0.41 SN - 0.43 ON, FP = 2.30 T - 1.18 SP_2O_5 - 0.45 OP_2O_5 and FK = 2.08 T - 0.19 SK_2O – 0.12 OK_2O.

Where, FN = fertilizer N (kg ha^{-1}), FP = fertilizer P_2O_5 (kg ha^{-1}), FK = fertilizer K_2O (kg ha^{-1}), T = yield target (q ha^{-1}), SN = soil test value for available N (kg ha^{-1}), SP_2O_5 = soil test value for available P_2O_5 (kg ha^{-1}), SK_2O = soil test value for available K_2O (kg ha^{-1}), ON = quantities of N supplied through FYM (kg ha^{-1}), OP_2O_5 = quantities of P_2O_5 through FYM (kg ha^{-1}), OK_2O = quantities of K_2O supplied through FYM (kg ha^{-1}). The treatment details are given below

The fertilizer recommendations based on initial soil test values for different yield target of wheat (40, 50 and 60 q ha^{-1}) under NPK alone and NPK with 10 t ha^{-1} at three locations were calculated (Table 2). The half dose of N and full dose of P_2O_5 and K_2O were applied and half dose of N applied in two splits. Nutrient uptake was calculated using data of yield and nutrient content in grain and straw. The post-harvest soil samples (0-15 cm) were collected and analyzed for organic carbon (Walkley and Black, 1934), available N (Subbiah and Asija, 1956), available P_2O_5 (Olsen *et al.,* 1954) and available K_2O (Jackson, 1973). The economics parameters of verification trial were calculated using following formulas:

Per cent achievement (%)

Yield obtained in the STCR treatment (kg/q/t ha^{-1}) / Yield targeted (kg/q/t ha^{-1}) x 100

Net return (Rs. ha^{-1})

Gross return (Rs. ha^{-1}) – Total cost of cultivation (Rs. ha^{-1})

Benefit-cost ratio

Net return (Rs. ha^{-1}) / Total cost of cultivation (Rs. ha^{-1})

The statistical analysis was carried out as per the randomized block design and the test of significance was carried by F test as described by Panse and Sukhatme (1967).

Results and Discussion

Grain yield

The results indicated that grain yield ranged from 19.00, 18.75 and 19.70 q ha^{-1} in control plots to 60.05, 59.00 and 60.12 q ha^{-1} in STCR-NPK with 10 t ha^{-1} FYM treatment (60 q ha^{-1} yield target) at Agronomy farm, RRS farm and Farmer's field, respectively (Table 2). The maximum grain yield recorded under T_{12} (STCR-NPK with 10 t ha^{-1} FYM 60 q ha^{-1} targeted yield) was at par with the treatments T_{11} (STCR-NPK alone 60 q ha^{-1} targeted yield) at all three locations. The STCR based treatments (40, 50 and 60 q ha^{-1} yield target) significantly increased grain yield as compared to control and other treatments. In targeted yield treatments, STCR based fertilizer application with FYM enhanced grain yield as compared to STCR-NPK alone treatments. Similar trends of results were reported by Kumar (2011), Keram *et al.,* (2012) and Rai *et al.,* (2016).

The increased yield under STCR approach with and without FYM might be due to balanced use of fertilizers as per soil and crop demand for potential growth and development. Integration of FYM with STCR further increased the yield might be due to better conditioning of rhizospheric environment through FYM addition resulted in potential movement of water, air, temperature and nutrients in soil (Tiwari *et al.,* 2002; Solaiman and Rabbani, 2006 and Keram *et al.,* 2012).

Economics

The results showed that STCR based fertilizer application with and without FYM gave higher value of produce than rest of the treatments due to higher wheat grain yield under STCR treatments. The treatment T_{12} (STCR-NPK with 10 t ha^{-1} FYM 60 q ha^{-1} targeted yield) gave higher gross return followed by T_{11}, T_{10}, T_9, T_8 and T_7. Similar trends were reported by Kumar (2011) for wheat crop. The targeted yield 50 q ha^{-1} with FYM gave highest per cent achievement (101.46) followed by targeted yield 40 q ha^{-1} with FYM (101.33). The per cent achievement of the targeted yield was within ±10% variation proving the validity of the equations for prescribing integrated fertilizer doses for wheat. The per cent achievement was higher in STCR-NPK with FYM as compared to STCR-NPK alone. Similar trends of results were obtained by Sellamuthu *et al.,* (2015) for wheat crop.

The maximum net gain over control was recorded in T_{12} (STCR-NPK with 10 t ha^{-1} FYM 60 q ha^{-1} targeted yield) followed by T_{11}, T_{10}, T_9, T_8 and T_7. The STCR based fertilizer application with FYM and without FYM (40, 50 and 60 q ha^{-1} targeted yield) gave higher net gain over control than FYM alone and RDF due to higher value of produce under STCR treatments. Similar trends were reported by Kumar (2011) for wheat crop.

The STCR based fertilizer application gave maximum net profit and B:C ratio over RDF and FYM alone. The net profit was decreased in STCR-NPK with FYM than STCR-NPK alone due to high cost of fertilizer and FYM

(10 t ha^{-1}) under STCR-NPK with FYM treatments. The B:C ratio was higher in treatment T_7 (STCR-NPK alone 40 q ha^{-1} targeted yield) followed by T_9 and T_{11}. The data indicated that STCR-NPK alone treatments (40, 50 and 60 q ha^{-1} targeted yield) gave higher B:C ratio over STCR-NPK with FYM treatments due to cost of FYM was added in STCR-NPK with FYM treatments.

N, P and K uptake

The STCR based application with and without FYM increased N, P and K uptake over control and other treatments. The N uptake by wheat ranged from 37.00 to 161.43 kg ha^{-1}at Agronomy farm, 32.60 to 151.92 kg ha^{-1}at RRS farm and 38.37 to 159.93 kg ha^{-1}at Farmer's field (Table 4).

The treatment T_{12} (STCR-NPK with 10 t ha^{-1} FYM 60 q ha^{-1} targeted yield) gave higher total N uptake by wheat at all three locations and at par with T_{11} at Farmer's field. Similar results were also obtained by Kumar (2011) and Sharma *et al.*, (2016). Higher uptake in NPK with FYM in target yield treatment might have improved plant health by accelerating initial process of plant growth such as cell division, number of root hairs enabling the plant to have healthy root system that helped in better absorption of nutrients and moisture from soil and ultimately the yield.

The total P uptake of wheat ranged from 5.80 to 24.02 kg ha^{-1}at Agronomy farm, 5.28 to 21.15 kg ha^{-1} at RRS farm and 5.78 to 23.62 kg ha^{-1} at Farmer's field (Table 4).

The treatment T_{12} (STCR-NPK with 10 t ha^{-1} FYM 60 q ha^{-1} targeted yield) gave higher total P uptake of wheat at all three locations which was at par with T_{10} and T_{11} at RRS farm and T_{11} (STCR-NPK alone 60 q ha^{-1} targeted yield) at Agronomy farm and Farmer's field. Similar results were also obtained by Kumar (2011) and Sharma *et al.*, (2016). The increased in P uptake could be the results of enhanced physiological processes within the plant system which resulted in the increased absorption of P by wheat plant and hence the translocation of P, might occurs and get accumulated in grain resulted higher uptake.

The total K uptake by wheat ranged from 43.53 to 142.47 kg ha^{-1}at Agronomy farm, 41.68 to 123.90 kg ha^{-1}at RRS farm and 43.21 to 140.73kg ha^{-1}at Farmer's field (Table 4). The maximum total K uptake by wheat was recorded in T_{12} (STCR-NPK with 10 t ha^{-1} FYM 60 q ha^{-1} targeted yield) at all three locations which was at par with T_{10} and T_{11} at Agronomy farm, T_8, T_9, T_{10} and T_{11} at RRS farm and T_{11} at Farmer's field. The increased nutrient uptake by wheat with integrated application of nutrients might be due to improvement of soil environment which encouraged proliferation of roots resulting in more absorption of water and nutrients from larger area and depth. Similar results were obtained by Kumar (2011) and Sharma *et al.*, (2016).

Post-harvest soil fertility status

The data indicated that organic carbon content in soil after harvest of wheat ranged from 0.40, 0.37 and 0.45 per cent to 0.52, 0.52 and 0.59 per cent at Agronomy farm, RRS farm and Farmer's field, respectively (Table 5). The STCR-NPK with FYM improved organic C content in soil due to addition of 10 t ha^{-1} FYM.

The addition of N, P and K fertilizers and FYM might have resulted in the improvement of root and shoot growth. Higher production of root biomass might have increased the organic C content (Subramanium and Kumaraswamy, 1989). Similar results were also reported by Kumar (2011) for wheat.

Table.1

1.	**Control**
2.	FYM
3.	Recommended dose of fertilizers (RDF)
4.	RDF with 10 t ha^{-1} FYM
5.	RDF as per STV without FYM
6.	RDF as per STV with 10 t ha^{-1} FYM
7.	40 q ha^{-1} targeted yield without FYM
8.	40 q ha^{-1} targeted yield with 10 t ha^{-1} FYM
9.	50 q ha^{-1} targeted yield without FYM
10.	50 q ha^{-1} targeted yield with 10 t ha^{-1} FYM
11.	60 q ha^{-1} targeted yield without FYM
12.	60 q ha^{-1} targeted yield with 10 t ha^{-1} FYM

Table.2 Initial soil test value of three locations for verification trial

Name of location	Organic C (%)	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Agronomy farm	0.43	211.54	29.56	270.12
RRS farm	0.41	196.89	34.56	295.91
Farmer's field	0.48	234	37.26	307.12

Table.3 Fertilizer doses (kg ha^{-1}) imposed in three locations based on fertilizer prescription equation

Tr. no.	Treatments	Agronomy farm			RRS farm			Farmer's field		
		FN	FP	FK	FN	FP	FK	FN	FP	FK
T_1	Control	0	0	0	0	0	0	0	0	0
T_2	FYM (10 t ha^{-1})	0	0	0	0	0	0	0	0	0
T_3	Recommended dose of fertilizers (RDF)	120	60	0	120	60	0	120	60	0
T_4	RDF with 10 t ha^{-1} FYM	120	60	0	120	60	0	120	60	0
T_5	RDF as per STV	160	60	0	160	60	0	160	60	0
T_6	RDF as per STV with 10 t ha^{-1} FYM	160	60	0	160	60	0	160	60	0
T_7	STCR-NPK alone (40 q ha^{-1} targeted yield)	106	57	32	112	51	27	97	48	25
T_8	STCR-NPK with 10 t ha^{-1} FYM (40 q ha^{-1} targeted yield)	86	46	25	92	40	20	77	37	18
T_9	STCR-NPK alone (50 q ha^{-1} targeted yield)	154	80	53	160	74	48	145	71	46
T_{10}	STCR-NPK with 10 t ha^{-1} FYM (50 q ha^{-1} targeted yield)	134	69	46	140	63	41	125	60	39
T_{11}	STCR-NPK alone (60 q ha^{-1} targeted yield)	202	103	74	208	97	69	193	93	67
T_{12}	STCR-NPK with 10 t ha^{-1} FYM (60 q ha^{-1} targeted yield)	182	92	67	188	86	62	173	83	60

(Where, FN, FP and FK are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively)

Table.4 Grain yield and economics of verification trial on wheat

Tr no.	Treatments	Grain yield (q ha^{-1})			*Per cent achieve--ment	*Value of produce (Rs. ha^{-1})	*Cost of fertilizer +FYM (Rs. ha^{-1})	*Net gain over control (Rs. ha^{-1})	*Net profit (Rs. ha^{-1})	*B:C ratio
		Agronomy farm	RRS farm	Farmer's field						
T_1	Control	19.00	18.75	19.70	-	35236	-	-	-	-
T_2	FYM (10 t ha^{-1})	22.24	21.50	21.74	-	40161	4000	4925	925	0.23
T_3	Recommended dose of fertilizers (RDF)	29.83	28.93	29.36	-	54047	4170	18810	14641	3.51
T_4	RDF with 10 t ha^{-1} FYM	30.08	29.13	29.58	-	54458	8170	19221	11052	1.36
T_5	RDF as per STV	34.94	33.68	34.50	-	63247	4684	28011	23327	4.98
T_6	RDF as per STV with 10 t ha^{-1} FYM	35.22	33.86	34.66	-	63627	8684	28391	19707	2.27
T_7	STCR-NPK alone (40 q ha^{-1} targeted yield)	40.32	40.21	40.35	100.73	74139	4326	38903	34577	8.02
T_8	STCR-NPK with 10 t ha^{-1} FYM (40 q ha^{-1} targeted yield)	40.60	40.44	40.56	101.33	74581	7413	39345	31932	4.31
T_9	STCR-NPK alone (50 q ha^{-1} targeted yield)	50.46	50.22	50.88	101.04	92956	6475	57720	51245	7.93
T_{10}	STCR-NPK with 10 t ha^{-1} FYM (50 q ha^{-1} targeted yield)	50.70	50.45	51.05	101.46	93349	9561	58113	48552	5.08
T_{11}	STCR-NPK alone (60 q ha^{-1} targeted yield)	59.87	58.79	59.96	99.23	109553	8624	74317	65693	7.63
T_{12}	STCR-NPK with 10 t ha^{-1} FYM (60 q ha^{-1} targeted yield)	60.05	59.00	60.12	99.53	109891	11711	74655	62944	5.38
S.Em.±		2.07	1.81	1.94	-					
C.D. (P=0.05)		6.08	5.32	5.68						

(*Mean values of three locations; Price = Wheat grain: 1840 Rs. q^{-1}, FYM: 40 Rs. q^{-1}, Urea: 5.92 Rs. kg^{-1}, SSP: 7 Rs. kg^{-1}, MOP: 15 Rs. kg^{-1})

Table.5 Effect of STCR based fertilizer application on N, P and K uptake (kg ha^{-1}) of wheat at three locations

Tr. no.	Treatments	Agronomy farm			RRS farm			Farmer's field		
		N	P	K	N	P	K	N	P	K
T_1	Control	37.00	5.80	43.53	32.60	5.28	41.68	38.37	5.78	43.21
T_2	FYM(10 t ha^{-1})	49.34	8.19	61.66	42.07	8.01	56.40	47.46	8.15	59.60
T_3	Recommended dose of fertilizer (RDF)	74.88	11.39	73.13	66.98	10.32	70.99	67.31	10.70	72.86
T_4	RDF with 10 t ha^{-1} FYM	78.04	12.23	87.20	71.32	10.66	80.00	73.00	11.46	84.26
T_5	RDF as per STV	82.62	12.24	79.56	72.37	11.66	78.55	79.42	11.87	83.17
T_6	RDF as per STV with 10 t ha^{-1} FYM	96.21	13.37	87.98	87.61	12.60	85.24	81.08	12.32	86.82
T_7	STCR-NPK alone (40 q ha^{-1} targeted yield)	100.65	14.86	94.25	91.34	13.94	98.42	103.49	14.12	97.04
T_8	STCR-NPK with 10 t ha^{-1} FYM (40 q ha^{-1} targeted yield)	108.95	15.82	108.46	96.45	15.25	109.84	111.73	15.21	103.44
T_9	STCR-NPK alone (50 q ha^{-1} targeted yield)	123.20	19.60	120.13	117.98	18.31	117.66	125.83	18.57	124.37
T_{10}	STCR-NPK with 10 t ha^{-1} FYM (50 q ha^{-1} targeted yield)	133.41	20.16	128.09	126.69	19.69	123.44	135.19	19.35	125.13
T_{11}	STCR-NPK alone (60 q ha^{-1} targeted yield)	145.56	22.12	131.05	132.51	19.93	119.78	150.99	23.09	133.73
T_{12}	STCR-NPK with 10 t ha^{-1} FYM (60 q ha^{-1} targeted yield)	161.43	24.02	142.47	151.92	21.15	123.90	159.93	23.62	140.73
S.Em.±		5.20	0.71	4.98	4.91	0.71	5.77	4.79	0.60	5.15
C.D. (P=0.05)		15.25	2.08	14.59	14.39	2.08	16.94	14.06	1.77	15.09

Table.6 Effect of STCR based fertilizer application on organic carbon (%), available N, P_2O_5 and K_2O (kg ha^{-1}) content in soil after harvest of wheat at three locations

Tr. no.	Treatments	Agronomy farm				RRS farm				Farmer's field			
		Organic carbon	Avail. N	Avail. P_2O_5	Avail. K_2O	Organic carbon	Avail. N	Avail. P_2O_5	Avail. K_2O	Organic carbon	Avail. N	Avail. P_2O_5	Avail. K_2O
T_1	Control	0.40	180.17	16.52	221.12	0.37	168.76	19.17	230.28	0.45	195.59	22.37	234.48
T_2	FYM(10 t ha^{-1})	0.47	193.49	24.56	250.03	0.48	181.12	26.43	253.35	0.54	205.18	30.88	265.23
T_3	Recommended dose of fertilizers (RDF)	0.39	200.17	25.77	247.26	0.38	189.01	28.57	251.59	0.46	211.90	33.15	258.09
T_4	RDF with 10 t ha^{-1} FYM	0.45	205.51	28.91	248.51	0.47	195.13	30.43	254.66	0.52	220.32	34.24	258.93
T_5	RDF as per STV	0.42	207.04	29.90	250.51	0.40	198.32	31.64	255.89	0.45	226.09	37.07	264.87
T_6	RDF as per STV with 10 t ha^{-1} FYM	0.50	216.63	33.34	254.89	0.51	202.74	34.74	258.16	0.56	233.69	39.31	266.82
T_7	STCR-NPK alone (40 q ha^{-1} targeted yield)	0.40	211.73	27.66	271.78	0.39	197.30	31.21	298.80	0.43	234.57	38.02	302.09
T_8	STCR-NPK with 10 t ha^{-1} FYM (40 q ha^{-1} targeted yield)	0.47	214.59	29.68	275.23	0.49	198.95	35.17	300.51	0.59	236.61	38.93	308.48
T_9	STCR-NPK alone (50 q ha^{-1} targeted yield)	0.42	220.03	34.67	278.12	0.41	198.24	38.04	310.89	0.46	235.41	37.68	312.55
T_{10}	STCR-NPK with 10 t ha^{-1} FYM (50 q ha^{-1} targeted yield)	0.50	224.64	36.40	280.93	0.52	201.53	39.48	311.63	0.57	240.28	39.70	316.52
T_{11}	STCR-NPK alone (60 q ha^{-1} targeted yield)	0.41	222.95	34.07	289.14	0.41	212.03	38.56	309.72	0.43	242.92	42.74	318.35
T_{12}	STCR-NPK with 10 t ha^{-1} FYM (60 q ha^{-1} targeted yield)	0.52	227.71	37.62	294.84	0.50	214.69	40.77	313.75	0.59	245.70	46.08	324.47
S.Em.±		0.02	9.03	1.44	10.38	0.02	8.07	1.72	11.94	0.02	10.33	1.67	11.73
C.D. (P=0.05)		0.04	26.48	4.23	30.45	0.05	23.66	5.06	35.03	0.05	30.29	4.91	34.42

The results indicated that available N after harvest of wheat varied from 180.17 to 227.71 kg ha^{-1} at Agronomy farm, 168.76 to 214.69 kg ha^{-1} at RRS farm and 195.59 to 245.70 kg ha^{-1} at Farmer's field (Table 5). The treatment T_{12} significantly increased available N content in soil which was at par with T_4, T_5, T_6, T_7, T_8, T_9, T_{10} and T_{11} at all locations. The STCR-NPK with FYM improved available N content in soil as compared to STCR-NPK alone might be due to enhanced mineralization of FYM which may be helped in build-up of available N in soil (Yaduvanshi *et al.,* 2013). Similar trends of results were obtained by Sellamuthu *et al.,* (2015) for wheat crop and Sharma *et al.,* (2016) for pearl millet and wheat crop.

The available P_2O_5 content in soil after harvest of wheat ranged from 16.52 to 37.62 kg ha^{-1} at Agronomy farm, 19.17 to 40.77 kg ha^{-1} at RRS farm and 22.37 to 46.08 kg ha^{-1} at Farmer's field (Table 5). The treatment T_{12} gave maximum available P_2O_5 content in soil at all three locations which was at par with T_{11} at Farmer's field and T_9, T_{10} and T_{11} at Agronomy farm and RRS farm. The build-up of available P_2O_5 with the application of NPK fertilizers alone or in conjunction with FYM may be due to release of some organic acids during decomposition which in turn helped in releasing the phosphorus through solubilizing action of native phosphorus in the soil. Similar type of results were obtained by Sellamuthu *et al.,* (2015) and Kumar (2011) for wheat crop.

The data indicated that available K_2O content in soil after harvest of wheat ranged from221.12 to 294.84kg ha^{-1} at Agronomy farm, 230.28 to 313.75 kg ha^{-1} at RRS farm and 234.48 to 324.47kg ha^{-1} at Farmer's field. The results revealed that maximum available K_2O content in soil was recorded in T_{12} at all three locations which was at par with T_7, T_8, T_9, T_{10} and T_{11} at all locations. The increased in available K_2O due to addition of FYM might be ascribed to the reduction of potassium fixation and release of K in soil solution. Similar trends of results were also obtained by Kumar (2011) for wheat crop and Sharma *et al.,* (2016) for pearl millet and wheat crop.

The STCR based fertilizer application with and without FYM (40, 50 and 60 q ha^{-1}) gave higher grain yield, value of produce, per cent achievement, net gain over control and B:C ratio over recommended dose of fertilizer (RDF). The per cent achievement of the targeted yield was within±10% variation proving the validity of the equations for wheat. The STCR treatments (40, 50 and 60 q ha^{-1} targeted yield) with 10 t FYM ha^{-1} was superior over STCR treatments (40, 50 and 60 q ha^{-1} targeted yield) without FYM and recommended dose of fertilizer (RDF) in terms of yield, nutrients uptake and fertility status of the soil.

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